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THE EFFECTS OF WASTE WATER DISCHARGES ON THE FLAVOR OF FISHES IN THE MISSOURI RIVER, OCTOBER, 1969

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National Field Investigations Center
Cincinnati, Ohio

1970

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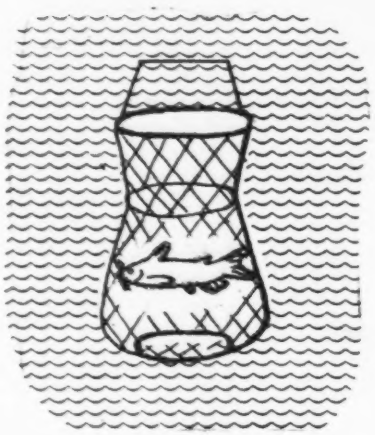

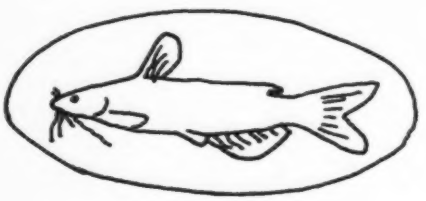

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EFFECTS OF WASTE WATER DISCHARGES ON THE FLAVOR OF FISHES IN THE MISSOURI RIVER (SIOUX CITY, IOWA, TO WAVERLY, MISSOURI)

OCTOBER 1969

Nelson A. Thomas
and
Delbert B. Hicks

A Study Report for Distribution by the
Director, Missouri Basin Region, FWQA

Prepared by

Water Sciences Section
National Field Investigations Center
Federal Water Quality Administration
United States Department of the Interior
Cincinnati, Ohio

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SUMMARY

1. An investigation of effects of pollutants on fish flavor was conducted on the Missouri River from Sioux City, Iowa, downstream to Waverly, Missouri. Test channel catfish were placed upstream and downstream from all known significant waste discharges in this reach. After four days exposure, they were removed, dressed, quick frozen, and submitted to a food-flavor test panel.
2. Fish held in the Missouri River in a one mile reach downstream from slaughterhouses and industrial waste discharges at Sioux City, Iowa, had an unacceptable flavor. Pieces of meat scraps and fat littered the water surface and collected on the baskets containing the fish.
3. Downstream from the Council Bluffs and Twin Cities sewage discharges, caged fish acquired an unacceptable flavor.
4. Downstream from the Omaha sewage treatment plant discharge, fish acquired the most unacceptable flavor of any tested in the study. Wastes from the Omaha sewage treatment plant caused an unacceptable flavor in fish for 2.5 miles of river along the Nebraska shore.

The discharge of inadequately treated wastes from the Omaha sewage treatment plant produced slimes in the river that collected on the cages, another indication of the severity of pollution in this area.

5. Test fish placed in the Missouri River downstream from the confluence of the Platte River to Kansas City, Kansas, had an acceptable flavor.
6. Wastes in runoff from the Fairfax dump at Kansas City, Kansas, caused fish to have an unacceptable flavor.
7. Fish placed in the Kansas River acquired an unacceptable flavor.
8. Wastes in the Kansas River and from the Kansas City, Kansas, and Kansas City, Missouri, sewage treatment plants discharge combined to cause an unacceptable flavor in caged fish in 2.5 miles along the south shore of the Missouri River.
9. Slime growths stimulated by wastes from Corn Products Company plant covered baskets placed 1000 feet downstream from the outfall and suffocated the test fish.
10. Fish placed along the north shore of the river downstream from the North Kansas City, Missouri, sewage treatment plant (Rock Creek) acquired an unacceptable flavor.

11. Fish placed in the Big Blue River and immediately downstream from its confluence with the Missouri River died within 24 hours indicating that these waters were toxic. Fish placed farther downstream in the Missouri River (one-half mile) possessed an unacceptable flavor.

12. The Old Blue River and Sugar Creek waters were toxic to fish. Caustic wastes in Sugar Creek dissolved the meat leaving only skin and bones in the basket. Fish in the Missouri River downstream from Sugar Creek acquired even more of an unacceptable flavor than fish at the next upstream station.

13. Wastes discharged to the Missouri River and its tributaries from the Kansas City area not only caused an unacceptable flavor in test fish for 22 miles, but were toxic to fish.

14. Of the 440 mile reach of the Missouri River studied, unacceptable flavors were found in fish placed at locations bracketing a total of 26 miles of river, all of which were confined to metropolitan areas.

STANDARDS VIOLATIONS

1. The State of Iowa general standard that surface waters be "Free from materials attributable to municipal, industrial or other discharges producing color, odor, or other conditions in such degree to be detrimental to legitimate uses of water" was violated by the discharge of industrial wastewater at Sioux City, Iowa, and the sewage discharges from Council Bluffs and Twin cities, Iowa.

2. The State of Nebraska standard "Concentrations of substances shall be less than that amount which is or may become injurious to the designated uses" was violated by the wastewater discharge from the Omaha sewage treatment plant.

3. The State of Kansas standard "Taste and odor producing substances from man-made sources shall be limited to concentrations in rivers that will not interfere with ... or impart unpalatable flavors to fish ... " was violated by wastes in the runoff from the Fairfax dump at Kansas City, Kansas, and wastewater discharges to the Kansas River.

4. The State of Missouri standard "Taste and odor producing substances from man-made sources shall be limited to concentrations in rivers that will not interfere with ... or impart unpalatable flavors to fish ... " was violated by the discharge of wastewater to the Kansas River and from the Kansas City, Kansas, and Kansas City, Missouri, sewage treatment plant discharges. The standard also was violated by the wastewater from the North Kansas City, Missouri, sewage treatment plant (Rock Creek), the South Kansas City, Missouri, sewage treatment plant (Big Blue River), and industrial wastewater carried by Sugar Creek to the Missouri River.

EFFECTS OF WASTE WATER DISCHARGES ON THE
FLAVOR OF FISHES IN THE MISSOURI RIVER
(SIOUX CITY, IOWA, TO WAVERLY, MISSOURI)

OCTOBER 1969

At the request of the Regional Director of the Missouri Basin Region, FWPCA, to investigate waste discharges that may effect an unacceptable flavor in fish in the Missouri River from Sioux City, Iowa, to downstream from Kansas City, Kansas, the National Field Investigations Center conducted fish flesh tainting studies from September 29 to October 18, 1969. The study reach extended from Sioux City, Iowa [River Mile (R.M.) 735] to Waverly, Missouri (R.M. 295) (Figure 1).

Fishermen have captured fish which possessed unacceptable flavors from the Missouri River. Because of this, sports fishermen have sought new uncontaminated fishing waters where their catch will be edible. Commercial fishermen have lost dressed fish markets because of consumer rejection of fish with unacceptable flavors and must sell their catches at reduced prices as live fishes for stocking ponds where with time the flavor will improve.

The study was directed to the identification of waste discharges that cause unacceptable flavor in channel catfish

(Ictalurus punctatus Rafinesque). This fish is one of the most important commercial and game fish in the Missouri River.

The commercial fishery on the Missouri River is a valuable resource. In 1966, 4.5 million pounds of fish valued at $315,000 were harvested from the Missouri River. In the states of Iowa, Kansas, Missouri and Nebraska, there were 292 Missouri River commercial fishermen. However, the vast majority of people who fish on the Missouri River are sports fishermen. It should be recognized that the Missouri River has both an important sport and commercial fishery and these should be protected and improved.

States bordering the Missouri River have endeavored to protect the Missouri River fishery resources by Water Quality Standards. The State of Nebraska Standards for taste and odor producing substances, state, "Concentrations of substances shall be less than that amount which is or may become injurious to the designated uses."

Water Quality Standards for the State of Missouri state, "Taste and odor producing substances discharged shall be limited to concentrations in the stream that will not interfere with... or impart unpalatable flavor to food fish,..." Water Quality Standards for the State of Kansas state for the Kansas and Missouri rivers that, "Taste and odor producing substances from man-made

sources shall be limited to concentrations in rivers that will not interfere with...or impart unpalatable flavor to fish,..." The State of Iowa Standards include the general criteria which provide that surface waters be "Free from materials attributable to municipal, industrial or other discharges producing color, odor or other conditions in such degree as to be detrimental to legitimate uses of water."

METHOD

The method employed on the Missouri River to identify waste sources producing an unacceptable flavor in catfish was to place untainted catfish in cages located upstream and downstream from suspected waste sources. This procedure has been found to successfully relate the unacceptable flavor produced in native fish to particular waste sources.

To ensure uniform taste quality before exposure, all fish were held in 62° F well water for a period of 10 days. After this period, some fish were cleaned and frozen on dry ice as reference fish. After the fish were transferred to the test sites, four fish each were placed in fish cages and suspended approximately two feet beneath the water's surface. Fish were exposed to waters for 96 hours.

The Missouri River was divided into four test reaches:

(1) The Sioux City reach (mile 735 to 691) encompassed 16 test sites.

(2) The Omaha reach (river mile 628 to 562) included 21 test sites.

(3) The St. Joseph reach (river mile 452.4 to 391) had 11 sites.

(4) The Kansas City reach (river mile 378 to 295) had 25 test sites.

After exposure, the fish were dressed and frozen on dry ice. The control and exposed samples were shipped to the Department of Food Science and Technology, Oregon State University, Corvallis, Oregon, where samples were stored at 0° F until testing. For testing, frozen catfish were washed, wrapped in aluminum foil, placed on slotted, broiler-type pans, and cooked in a gas oven at 400° F for 23 to 45 minutes depending on the size of the fish. Each sample was boned and the flesh flaked and mixed to insure a uniform sample. Samples were served in coded cups to judges seated in individual test booths. Known and coded references or control samples were included in each test. The judges scored the flavor and desirability of each sample on a seven point scale ranging from 7, no unnatural flavor or very desirable, to 1, very extreme unacceptable flavor or very undesirable. Fish flesh having scores of 5.0 or higher were considered to have an acceptable flavor.

RESULTS

Fish placed upstream from Sioux City had an acceptable flavor. Test fish from the Big Sioux River also exceeded the acceptable value (5.0). Numerous fishermen observed in these areas attest to the popularity of these areas as fishing sites. Numerous slaughterhouses in Sioux City discharged their waste water into the Missouri River between river mile 732 and 731. Fish held in cages at river mile 731.5, 731.0 and 730.5 acquired an unacceptable flavor (Figure 2). Pieces of meat and fat collected on the baskets and could be seen floating in the water for several more miles downstream. Fish held at river mile 730.5 downstream from the slaughterhouses and other industries in Sioux City received the lowest flavor score of fish tested in this area (Table 1). Wastes discharged into the river at Sioux City caused an unacceptable flavor in caged fish in at least one mile of the Missouri River bordering Iowa.

No unacceptable flavor occurred in test fish placed along either side of the river from Dakota City, Nebraska, downstream to river mile 628.0 near Omaha, Nebraska. Test fish between river miles 628 and 624.6 retained near acceptable flavors (Figure 3). At river mile 622 (Iowa shore), the fish scored 4.3 indicating an

unacceptable flavor. At river mile 617, the test fish had a flavor score of 4.9 indicating a near acceptable flavor.

Along the Iowa side of the Missouri River, caged fish had acceptable flavors downstream to river mile 614.0 where the Council Bluffs and Twin Cities sewers discharged to the river and caused an unacceptable flavor in caged fish at river mile 612. Directly across the river on the Nebraska bank, the caged fish were rated with an acceptable flavor score of 5.2 (Figure 3). At river mile 611 (800 ft. downstream from the Omaha sewage treatment discharge), caged fish acquired the most unacceptable flavor (rating of 2.6) of any of the fish tested in 440 miles of the Missouri River studied. The discharge of inadequately treated wastes from the Omaha sewage treatment plant also sufficiently enriched the Missouri River to support slime growths that covered the cages. Slime growths indicate organic pollution which degraded the environment. Flavor of caged fish was still severely degrade 900 feet downstream from the slaughterhouse discharges which entered the river approximately one-half mile downstream from the Omaha sewage treatment plant outfall. Caged catfish from both sides of the Missouri River at river mile 608 were rated with acceptable flavor scores (Figure 3).

Wastes from the Omaha sewage treatment plant degraded the flavor of fish in 2.5 miles of river along the Nebraska shore. Wastes from the Council Bluffs and Twin Cities sewage discharges degraded the flavor in caged fish to make them unacceptable in 2.5 miles of river along the Iowa shore.

The flavor of caged catfish was acceptable from river mile 608 to upstream from Kansas City, Kansas, at river mile 378 (Figure 4). Along the Kansas side of the Missouri River two miles downstream from the Fairfax dump (river mile 372), caged fish had an unacceptable flavor (rating of 3.6). At river mile 367.8, approximately .3 mile upstream from the Kansas River confluence, fish flavor was acceptable indicating dilution of the compounds from the Fairfax dump.

Test fish from the Kansas River (river mile 367.5-0.5) had an unacceptable flavor rating of 2.9. Downstream from river mile 367.5, along the south shore of the Missouri River, the combined effects of the Kansas River and waste water discharged from a Kansas City, Kansas, and a Kansas City, Missouri, sewage treatment plant caused an unacceptable flavor in fish held at river mile 366.6 and 364.2 (Figure 4). Fish placed across the river (north shore) at river mile 365.6, 364.0, and 363.0 did not acquire an unacceptable flavor. However, fish placed in baskets

1000 feet downstream from the Corn Products Company waste discharge (river mile 365, Missouri's north shore) died because of suffocatio caused by dense slime growths covering the baskets. These growths did not occur upstream from Corn Products indicating the Corn Products Company was discharging inadequately treated wastes. The growths also covered the rocks of the jettys thus reducing habitat for fish food organisms in at least one mile of the river.

Test fish along the north bank of the river approximately 400 feet downstream from Rock Creek confluence at river mile 362.6 had an unacceptable flavor rating of 3.8. Rock Creek receives wastes from the North Kansas City, Missouri, sewage treatment plant.

Degradation of fish flavor was found along the south bank at river mile 358.2 where fish acquired an unacceptable flavor rating of 4.2. Immediately upstream from this station, either a power or an industrial complex discharged their waste waters to the river.

Test fish in the Big Blue River died within four hours of planting and those fish placed in the Missouri River 200 feet downstream from the Big Blue River confluence died within 24 hours. One-half mile downstream at river mile 357.5, the caged fish acquired an unacceptable flavor rating of 3.0. The Old Blue River was also toxic; however, the unacceptable flavor of fish

in this reach of the Missouri River masked any further degradation caused by the Old Blue River. Wastes in Sugar Creek, river mile 356.7 - < 0.1, not only were toxic but also caustic which resulted in fish flesh being dissolved off the bones. After 96 hours, only skin and bones remained in the cages set in Sugar Creek. Approximately 200 feet downstream from the Sugar Creek confluence, the test fish were given even a lower flavor score (3.2) than had been given to the test fish downstream from the Old Blue River at river mile 356.9 (Table 1). Fish placed in baskets three miles downstream still had an unacceptable flavor as a result of wastes from the Big Blue and Old Blue rivers and Sugar Creek. Fish with acceptable flavors were recovered from the station at river mile 345. The fish downstream from the Little Blue River had only a slight unacceptable flavor (4.9). Fifty miles downstream at Waverly, Missouri, the fish scored 5.5 indicating acceptable flavor.

Wastes discharged to the Missouri River from the Kansas City, Kansas, North Kansas City and Kansas City, Missouri, and the Kansas River areas caused unacceptable flavors in fish for 22 miles. Wastes carried in Sugar Creek, the Big Blue and Old Blue rivers were toxic to test fish.

Table 1

Off-Flavor and Desirability Scores of

Caged Catfish, Missouri River, 1969

Missouri River Mile	Bank[1]	Location	Flavor Score	Desirability Score
		Control	5.9	5.3
734.6	R + L	Upstream from Sioux City	5.1	4.4
734.0-0.5[2]	R	Big Sioux River	5.5	4.7
732.0	R	Upstream from Old Floyd River	5.1	4.4
	R	SLAUGHTERHOUSE WASTE DISCHARGES		
731.5	R	Upstream from New Floyd River	4.7	3.9
	R	SLAUGHTERHOUSE WASTE DISCHARGES		
731.0	R	Downstream from New Floyd River	4.8	3.9
	R	SLAUGHTERHOUSE WASTE DISCHARGES		
730.5	R	Downstream from New Floyd River	4.3	3.3
729.5	R	Upstream from Sioux City Sewage Discharge	5.0	3.8
	R	SIOUX CITY SEWAGE DISCHARGE		
729.0	R	Downstream from Sioux City Sewage Discharge	5.0	4.0
728.1	R	Downstream from Sioux City Sewage Discharge	5.0	4.1

[1]Looking upstream.

[2]Miles upstream in tributary.

Missouri River Mile	Bank[1]	Location	Flavor Score	Desirability Score
728.0	L	**Upstream from slaughterhouse waste** Discharge	5.2	4.0
	L	SLAUGHTERHOUSE WASTE DISCHARGES		
726.2	L	Downstream from Slaughterhouse Waste Discharges, Dakota City, Nebraska	5.1	4.5
	L	DAKOTA CITY, NEBRASKA, SEWAGE DISCHARGE		
725.2	L	Downstream from Dakota City Sewage Discharge	5.6	4.7
723.5	L	Downstream from Dakota City Sewage Discharge	5.3	4.7
717.5	R	Downstream from Metropolitan Utilities District and Iowa Power and Light Co. Discharge	5.3	4.5
691.0	L	Decatur, Nebraska	5.0	4.3
628.0	R + L	Upstream from Omaha, Nebraska	5.1	4.6
625.0	L	Downstream from Metropolitan Utilities District Power Discharge	4.9	4.6
624.6	L	Upstream from Portland Cement	4.8	4.4
622.0	R	Downstream from Omaha Storm Sewer	4.3	4.0
617.0	R	Upstream from National Co-op Refinery	4.9	5.5
616.4	L	Omaha Municipal Dock and Cargill, Inc.	4.7	4.4
616.2	L	Downstream from Ditch from Railroad Yards	5.4	4.8

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Missouri River Mile	Bank [1]	Location	Flavor Score	Desirability Score
615.0	R	Upstream from Council Bluffs Sewage Discharge	5.1	4.2
614.8	L	Downstream from Quaker Oats Waste Discharge	4.9	4.1
		COUNCIL BLUFFS SEWAGE DISCHARGE		
614.0	R	Downstream from Council Bluffs Sewage Discharge	5.0	4.4
	R	TWIN CITIES SEWAGE DISCHARGE		
612.1	R	Downstream from Council Bluffs and Twin Cities Sewage Discharge	4.2	3.4
612.1	L	Upstream from Omaha Sewage Discharge	5.2	5.6
	L	OMAHA SEWAGE DISCHARGE		
611.0	L	Downstream from Omaha Sewage Discharge	2.6	1.6
	L	SLAUGHTERHOUSE WASTE DISCHARGE		
610.0	L	Downstream from Omaha Sewage discharge and Slaughterhouse Waste Discharges	3.8	2.8
608.0	L	Downstream from Omaha Sewage Discharges	5.4	4.6
608.0	R	Downstream from Council Bluffs Sewage Discharges	6.0	5.4
602.0	L	Upstream from Bellevue, Nebraska	5.4	4.7
599.0	L	Downstream from Bellevue Sewage Discharges	5.1	4.1
591.0	L	Plattsmouth, Nebraska	5.5	4.8

Missouri River Mile	Bank[1]	Location	Flavor Score	Desirability Score
562.0	L	Nebraska City, Nebraska	5.3	4.6
452.4	R	Upstream from St. Joseph, Missouri Water Intake	5.6	5.1
449.0	R	Downstream from a St. Joseph, Missouri, Storm Drain	5.7	5.2
447.0	R	Upstream from St. Joseph Sewage Discharge	5.6	4.9
	R	ST. JOSEPH MUNICIPAL STP		
446.0	R	Downstream from St. Joseph Sewage Discharge	5.8	5.4
		SOUTH ST. JOSEPH INDUSTRIAL SEWER DISTRICT STP OUTFALL		
444.0	R	Downstream from St. Joseph, Missouri Industrial Waste Discharge	5.4	4.8
440.0	R	Downstream from St. Joseph, Missouri	5.6	5.3
424.0	L	Upstream from Atchison, Kansas	5.9	5.4
421.0	L	Downstream from Atchison, Kansas	Fish cage lost	
398.0	L	Upstream from Leavenworth, Kansas	5.8	5.3
395.0	L	Downstream from Leavenworth, Kansas	5.4	5.0
391.0	R	Downstream from Platte River Confluence	5.9	5.0
378.0	L	Upstream from Kansas City, Kansas	5.1	4.5
	L	DRAINAGE FROM FAIRFAX DUMP		
370.4	R	Kansas City, Missouri, Water Intake	5.5	4.7
370.0	L	Downstream from Fairfax Dump	3.6	2.3
368.1	L	Kaw Valley Drainage District		
367.8	L	Upstream from Kansas River	5.5	4.7

Missouri River Mile	Bank[1]	Location	Flavor Score	Desirability Score
367.5-0.5	L	Kansas River	2.9	1.7
	L	KANSAS CITY, KANSAS, AND KANSAS CITY, MISSOURI, SEWAGE DISCHARGES		
366.6	L	Downstream from Kansas River confluence and Downstream from Kansas City, Mo., and Kansas City, Kansas, Sewage Discharges	3.9	2.7
365.6	R	Upstream from Corn Products Waste Discharge	5.4	4.4
	R	CORN PRODUCTS WASTE DISCHARGES		
364.2	L	Downstream from Kansas River and Kansas City, Mo., and Kansas City, Kansas, Sewage Discharges	4.6	3.5
364.0	R	Downstream from Corn Products Waste Discharge	5.5	4.4
363.0	R	Upstream from Rock Cr.	5.5	4.6
	R	NORTH KANSAS CITY, MISSOURI, SEWAGE DISCHARGES		
362.0	R	Downstream from Rock Cr.	3.8	2.6
358.2	L	Upstream from Big Blue River	4.2	3.5
358.0-0.5	L	Big Blue River	Toxic, Fish Died	
	L	KANSAS CITY, MISSOURI, SEWAGE DISCHARGE		
357.9	L	Downstream from Big Blue River	Toxic, Fish Died	
357.5	L	Downstream from Big Blue River	3.0	1.9

Missouri River Mile	Bank[1]	Location	Flavor Score	Desirability Score
357.2	L	Downstream from Big Blue River	3.5	2.2
357.0	L	Upstream from Old Blue River	3.0	1.7
357.0-<0.1	L	Old Blue River	3.5 Toxic to 3 of 4 test fish	2.1
356.9	L	Downstream from Old Blue River	3.6	2.7
356.7-<0.1	L	Sugar Cr.	Toxic, Caustic Dissolved Mat	
356.6	L	Downstream from Sugar Cr.	3.2	2.3
354.2	L	Downstream from Cement City, Missouri	4.2	3.1
345.0	R	Downstream from Missouri City Electric Power Discharge	5.4	4.7
339.5	L	Downstream from Little Blue River	4.9	4.0
295.0	L	Waverly, Missouri	5.5	4.7

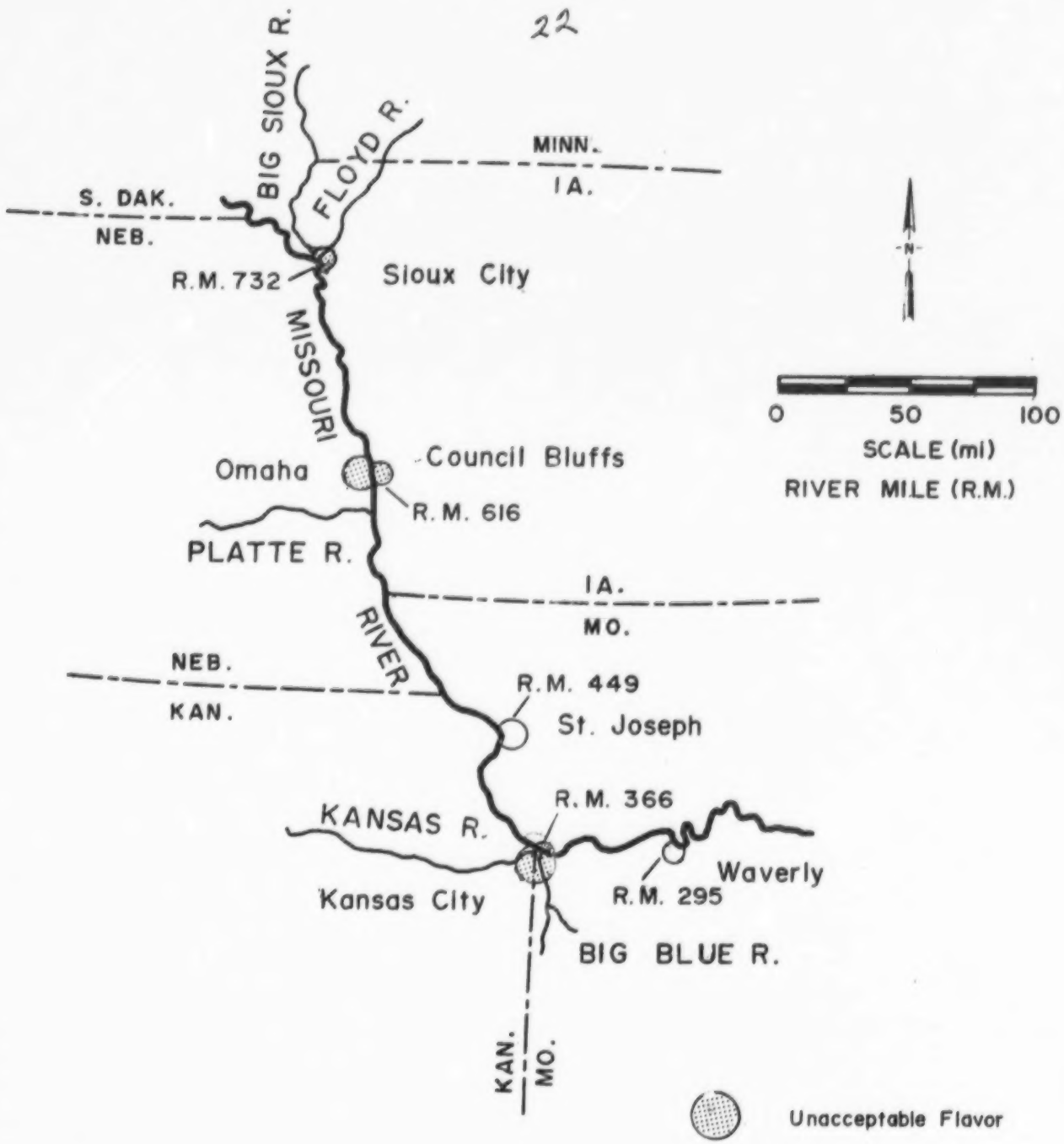

FIGURE I. FISH FLAVOR STUDY AREA AND REACHES OF UNACCEPTABLE FISH FLAVOR, MISSOURI RIVER, 1969.

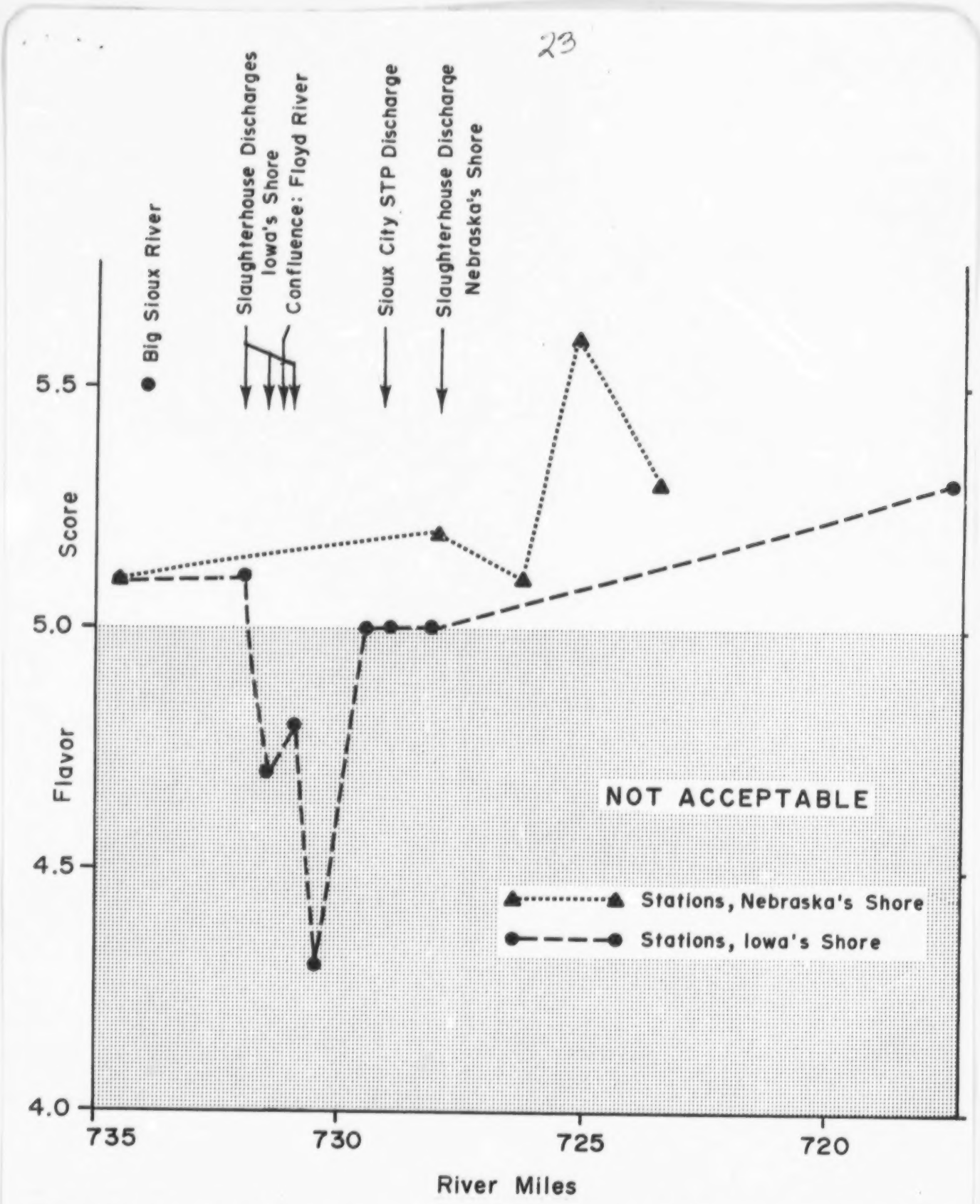

FIGURE 2. FLAVOR OF CAGED CHANNEL CATFISH, MISSOURI RIVER, NEAR SIOUX CITY, IOWA, 1969.

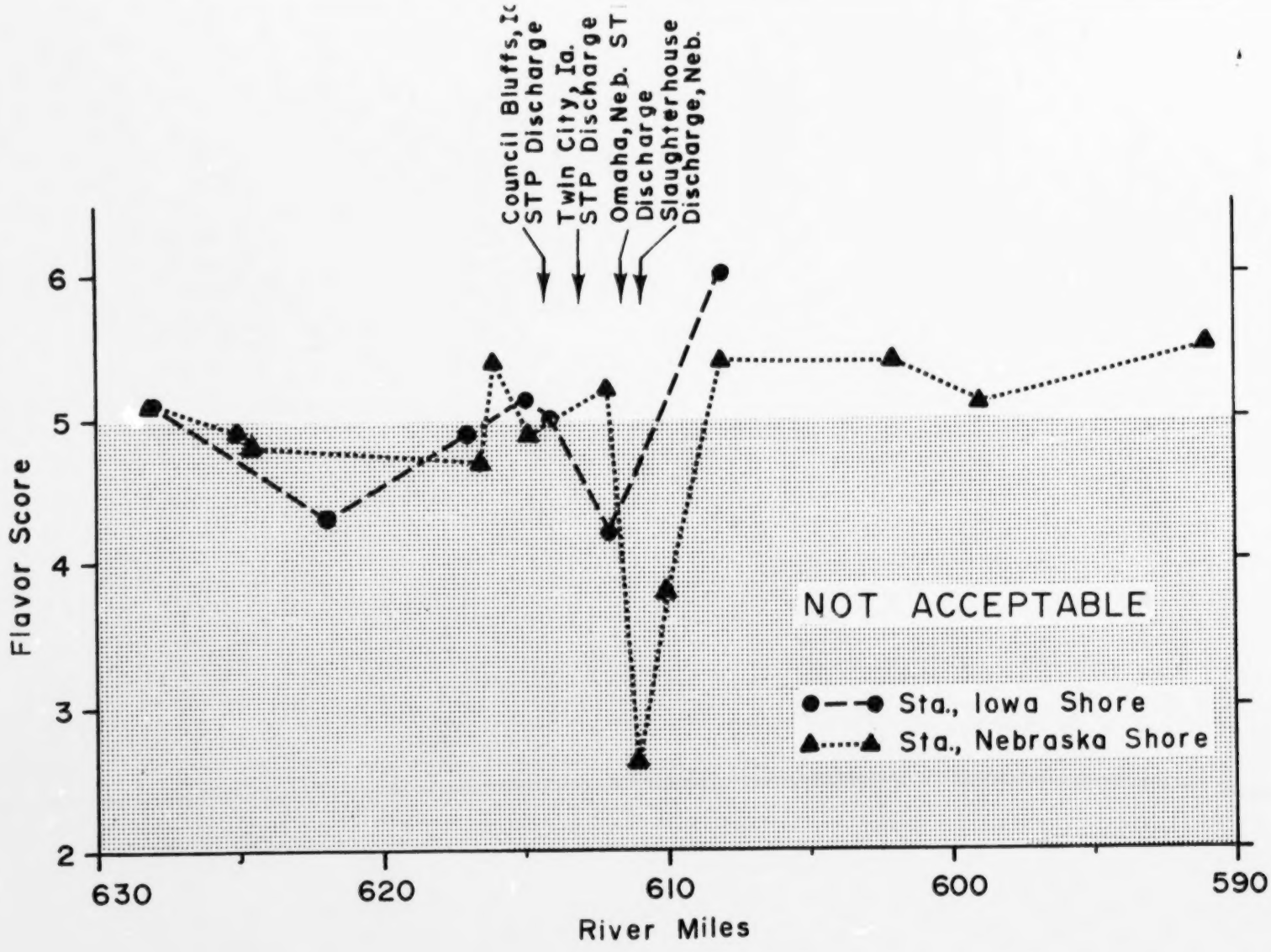

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FIGURE 3. FLAVOR OF CAGED CHANNEL CATFISH, MISSOURI RIVER, NEAR OMAHA, NEBRASKA, 1969.

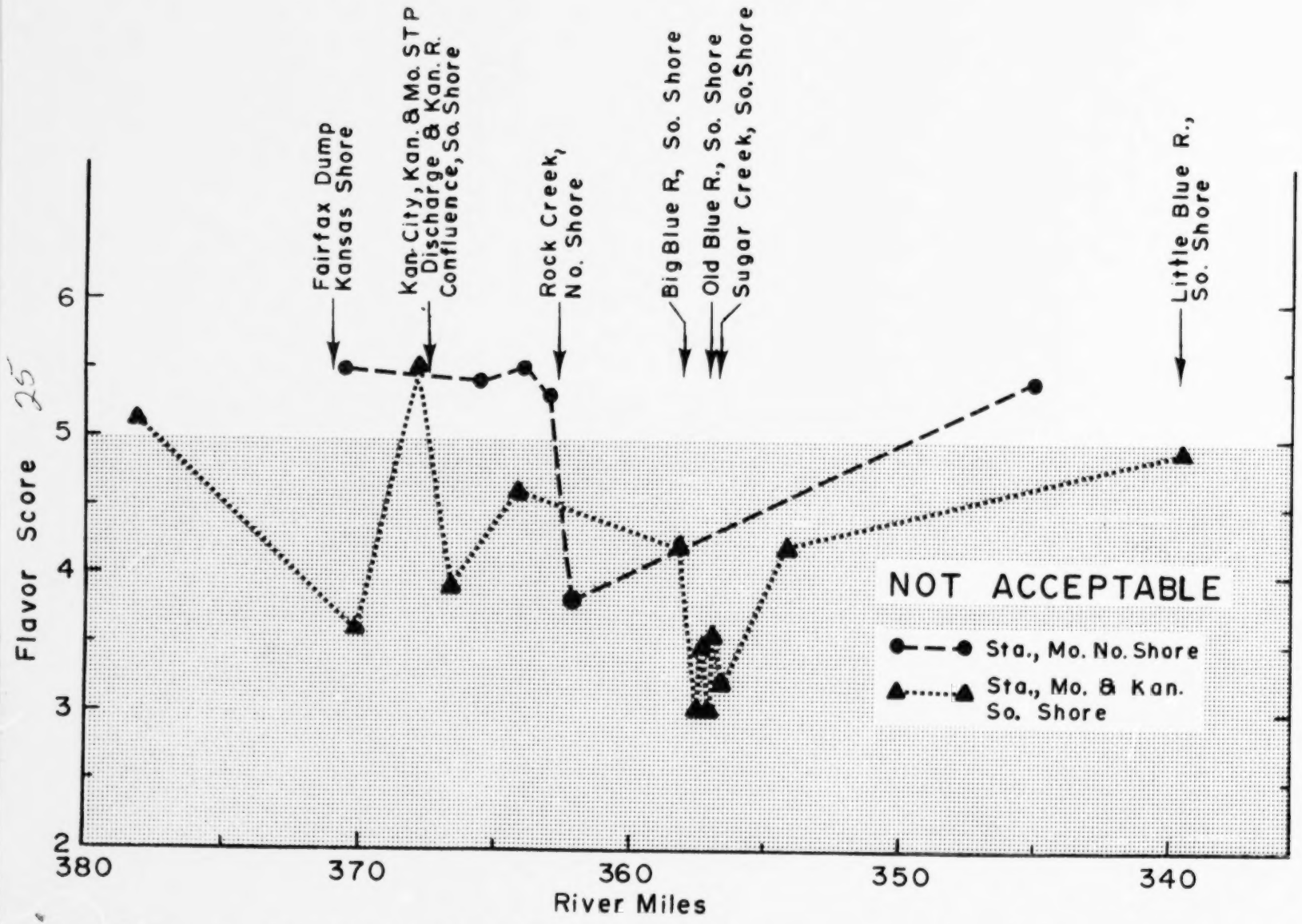

FIGURE 4. FLAVOR OF CAGED CHANNEL CATFISH, MISSOURI RIVER, NEAR KANSAS CITY, MISSOURI & KANSAS, 1969.